HSR Health Services Research

DOI: 10.1111/j.1475-6773.2010.01204.x
RESEARCH ARTICLE

Perceptions of Hospital Safety Climate and Incidence of Readmission

Luke O. Hansen, Mark V. Williams, and Sara J. Singer

Objective. To define the relationship between hospital patient safety climate (a measure of hospitals' organizational culture as related to patient safety) and hospitals' rates of rehospitalization within 30 days of discharge.
Data Sources. A safety climate survey administered to a random sample of hospital employees ($n = 36{,}375$) in 2006–2007 and risk-standardized hospital readmission rates from 2008.
Study Design. Cross-sectional study of 67 hospitals.
Data Collection. Robust multiple regressions used 30-day risk-standardized readmission rates as dependent variables in separate disease-specific models (acute myocardial infarction [AMI], heart failure [HF], pneumonia), and measures of safety climate as independent variables. We estimated separate models for all hospital staff as well as physicians, nurses, hospital senior managers, and frontline staff.
Principal Findings. There was a significant positive association between lower safety climate and higher readmission rates for AMI and HF ($p \leq .05$ for both models). Frontline staff perceptions of safety climate were associated with readmission rates ($p \leq .01$), but senior management perceptions were not. Physician and nurse perceptions related to AMI and HF readmissions, respectively.
Conclusions. Our findings indicate that hospital patient safety climate is associated with readmission outcomes for AMI and HF and those associations were management level and discipline specific.

Key Words. Safety culture, safety climate, hospital readmission

Preventable hospital readmission represents an increasingly prominent target in policy discussions aimed at reducing morbidity and cost in the U.S. health care system. Approximately one-fifth (19.6 percent) of Medicare fee-for-service beneficiaries will experience hospital readmission within 30 days of discharge (Jencks, Williams, and Coleman 2009). Up to three-quarters of these unplanned readmissions are potentially avoidable and are associated with an annual cost of U.S.$12 billion (MedPAC 2007). In response to these cost and quality implications, in July 2009 the Centers for Medicare and Medicaid

Services (CMS) began reporting 30-day risk-standardized readmission rates as a measure of hospital quality (Keenan et al. 2008). This was likely a first step toward readmission rates becoming a standard indicator of inpatient and post-discharge quality of care and a metric for performance-based reimbursement (Epstein 2009).

Reflecting a belief that hospital readmission is a function not only of patient morbidity but also of hospitals' management of safe transitions between the inpatient and the post-acute care setting, the Agency for Healthcare Research and Quality (AHRQ) and the National Quality Forum (NQF) have focused on the relationship between hospital readmission and patient safety (AHRQ 2009a, b; NQF 2009). Worse performance on AHRQ's Patient Safety Indicators (PSIs) has been associated with higher readmission rates (Friedman et al. 2009). Modeled in part on Project RED (Re-Engineered Discharge) at Boston University Medical Center (Jack et al. 2009), NQF has designated evidence-based improvement in "discharge systems" as a requisite hospital practice in order to be considered "safe."

If the frequency of readmission reflects inadequate patient safety processes in the hospital, then hospitals with worse safety culture would be expected to exhibit higher levels of hospital readmission. To evaluate this supposition, we examined the relationship of a measure of hospital patient safety culture—hospital patient safety climate—and hospital readmission. We used data from a survey measuring safety climate in a national sample of hospitals and CMS risk-standardized measures of 30-day hospital readmission.

BACKGROUND

Determinants of Hospital Readmission

Both patient factors and hospital discharge process elements appear to be associated with unplanned rehospitalization. At the patient level, risk factors for readmission include advanced age, comorbidities, and increased number of outpatient medications (David et al. 2000; Dobrzanska and Newell 2006). At the hospital level, hospitals that fail to perform evidence-based treatments experience higher rates of patient rehospitalization (Ashton et al. 1995; Chung

Address correspondence to Luke O. Hansen, M.D., M.H.S., Division of Hospital Medicine, Northwestern University Feinberg School of Medicine, 750 N. Lakeshore Drive, 11th floor, Ste. 191, Chicago, IL 60611; e-mail: l-hansen@northwestern.edu. Mark V. Williams, M.D., is with the Division of Hospital Medicine, Northwestern University Feinberg School of Medicine, Chicago, IL. Sara J. Singer, M.B.A., Ph.D., is with the Harvard School of Public Health, Boston, MA.

et al. 2008). Randomized trials indicate that readmission rates can be reduced by interventions targeting both patient risks and hospital processes, with absolute reductions in 30-day readmission rates between 5 and 15 percent through a combination of patient education, improved hand-offs of clinical information between hospital and community physicians, and follow-up phone calls after discharge (Naylor et al. 1999; Coleman et al. 2006; Jack et al. 2009).

Safety Culture in Health Care

Since the release of the Institute of Medicine's (IOM) transformational report on patient safety, *To Err Is Human*, health care organizations have become increasingly aware of their need to perform as "high reliability organizations." Drawing from industries including nuclear power and civil aviation that are guided by an imperative to reduce error in order to prevent harm, many in the health care industry endeavored to improve potential determinants of patient safety over the past decade. Among these is an organization's "safety culture," which describes the knowledge, beliefs, and attitudes that reflect the role of safety in the organization (Zohar 1980). This concept has been embraced by policy makers as one potential strategy to reduce preventable patient harm with endorsement by the IOM, The Joint Commission, and CMS (IOM 2006; The Joint Commission 2006; AHRQ 2009b). Underlying safety culture visibly manifests itself in organizations as elements of *safety climate*, including policies, procedures, and practices, which can be more easily measured through workforce perceptions (Singer et al. 2009a).

While the connection between a hospital safety climate and improved outcomes for hospitalized patients is emphasized by policy and regulatory organizations, evidence of this connection is limited. In particular, no evidence thus far has linked a supportive hospital safety climate with post-discharge outcomes such as hospital readmission. This relationship could be significant given the increasing belief that hospital readmission is affected by the quality of patient preparation for discharge and hospital staff attention to safe transition to the home or institutional aftercare setting (Coleman and Williams 2007). Different perceptions of the organization's safety climate among groups within the hospital, such as managers and frontline workers or physicians and nurses (Singer et al. 2008, 2009b), could suggest domains of safety climate or work roles to target in efforts to strengthen an organization's safety climate and potentially improve important patient outcomes.

Measurement of Hospital Safety Climate

Several surveys measure safety climate and provide increasing evidence of variation in safety climate among and within hospitals (Sorra and Nieva 2003; Sexton et al. 2006; Singer et al. 2008). Existing instruments vary in the subdomains of safety climate identified as well as the level of observation at which they have been used. The importance of effective communication among staff in maximizing safe practice is prominent across instruments. One instrument, the Patient Safety Climate in Healthcare Organizations (PSCHO) Survey, offers distinct opportunities for the measurement of safety climate as related to hospital-level phenomena such as readmission because it was optimized for hospital-wide implementation and hospital-level analysis, used to assess variation in safety climate by work role across hospitals and relationship with hospital-level outcomes, tested for psychometric reliability; and the authors have extensive experience with the instrument (Singer et al. 2007, 2009c).

Evidence of the Relationship between Hospital Patient Safety Climate and Patient Outcomes

Evidence from health care as well as other industries demonstrates that improved safety climate is associated with improved staff safety outcomes (Clarke 2006), and evidence demonstrating patient benefits associated with better safety climate is increasing. The relationship between patient safety climate and outcomes has been best described at the unit level (Pronovost et al. 2005; Hofmann and Mark 2006; Vogus and Sutcliffe 2007a). Measurement of the effect of safety climate measured at the level of the hospital, management position, or job type is limited. Singer and colleagues demonstrated that significant variation in perceived safety climate does exist by work role (Hartmann, Meterko, and Rosen 2009; Singer et al. 2009b) and that hospitals whose frontline staff perceived a better safety climate were less likely to experience adverse PSI events (Singer et al. 2009d; Rosen et al. 2010).

Hypotheses

Existing evidence suggests that the quality of inpatient care is associated with readmission (Ashton et al. 1995, 1997). As a potentially important determinant of hospital quality, patient safety climate may be related to the risk of readmission. Several components of a safe transition from hospital to the postacute care setting including efforts to reduce medication error and to conduct effective communication among hospital staff and between hospital providers, community providers, and patients are dependent on the conscientious provision of specific services during the inpatient stay. Interventions that improve communication and reduce risk of medication error during a care transition have been shown to reduce avoidable hospital readmission (Coleman et al. 2006; Balaban et al. 2008; Jack et al. 2009; Koehler et al. 2009). Unlike skills that can be taught through technical training, conscientious behavior tends to be a function of group norms and values and of the policies and procedures designed to promote them. Even when providers have a roadmap that outlines steps to optimize the discharge process, organizational safety climate may determine the extent to which those processes are executed consistently and effectively. Thus, groups whose safety climate directs individuals toward greater attention to safe care may be more likely to practice safety behaviors that reduce readmission risk.

H_1: Higher levels of hospital safety climate will be associated with lower 30-day readmission rates.

Previous literature suggests that hospital senior managers' perception of their organization's safety climate may be misaligned with circumstances on the frontline. For example, the incidence of PSI events corresponded with frontline staff perceptions of safety climate but not with those of senior managers (Singer et al. 2009d). Similarly, the relationship between safety climate and hospital readmission rates may be better appreciated by frontline staff than senior managers. Because both safety climate and the discharge process are intensively dependent upon interpersonal processes occurring at the point of care, perceptions of safety climate among individuals closely experiencing interactions at the bedside may reflect more closely the likelihood of unsafe transitions and risk of readmission.

H_2: Frontline staff perceptions regarding safety climate will be more closely associated with patient readmission than senior management perceptions.

Just as differences may exist between senior managers' and frontline staff's perceptions of safety climate and the associated likelihood of readmission, it is possible that within the clinical care team certain work roles might correspond to perceptions of safety climate that afford better insight into readmission risk for specific disease conditions. For example, the risk of postsurgical complication requiring readmission following coronary artery bypass graft surgery and the elements of safety climate that might protect against such complications may be most accurately appreciated by a surgeon with rich technical experience in the procedure. In contrast, with regard to decompensation of a chronic disease such as heart failure (HF) in which both admission and readmission frequently result from failure of community-based therapy (Vinson et al. 1990; Tsuchihashi et al. 2001), care team members with close knowledge of a patient's community-based resources and the hospital's ability to coordinate a safe transition may assess safety climate at levels more closely associated with readmission following hospitalization for such disease.

Nurses experience significant exposure to the logistics of safe transitions between hospitals and home, including the delivery of discharge instructions regarding outpatient follow-up recommendations, teaching around medication changes and medication compliance, and transportation from the hospital. We thus expect that nurse assessments of safety climate will be more closely associated with readmission following hospitalization for decompensation of chronic disease and conditions requiring more intensive services at the time of discharge than diagnoses receiving definitive therapy during a hospitalization (e.g., percutaneous coronary intervention for acute myocardial infarction [AMI]).

Presently, CMS publicly reports 30-day readmission rates for Medicare beneficiaries following hospitalization for pneumonia, HF, and AMI. While HF represents a chronic illness in which admission most often results from decompensation in the outpatient setting, AMI is by definition an acute process in which 30-day readmission risk is less dependent on ongoing aftercare management and more dependent on lasting effects of inpatient therapy, specifically safe and effective percutaneous coronary intervention. Similarly, pneumonia represents acute infection with less dependence on intensive self-management and aftercare services.

H_{3A}: Nurse perceptions of safety climate will be more closely associated with readmission rates after hospitalization for acute decompensation of HF (i.e., nurse-sensitive readmission rates) than physician perceptions of safety climate.

H_{3B}: Physician perceptions of safety climate will be more closely associated with readmission after hospitalization for AMI and pneumonia (i.e., physician-sensitive readmission rates) than nurse perceptions of safety climate.

Methods

Data Sources

Data on hospital safety climate were obtained using the PSCHO survey. The 45 items in this survey use a five-point Likert scale ranging from "strongly agree" to "strongly disagree." Based on principal components analysis, the survey assesses 12 dimensions reflecting components of overall safety climate (e.g., senior management engagement in patient safety, the existence of a culture of blame, unit manager's responsiveness to identified safety problems) (Singer et al. 2009c). The PSCHO is scored to describe the "percent problematic response" (PPR) in order to better identify the prevalence of perceived poor safety climate. The use of PPR reflects the belief that high reliability requires not only a strong safety climate but also a high degree of agreement across an organization (Roberts 1990). The mean PPR was calculated for each individual item in the survey, for each dimension for the entire sample, and all survey items together. Mean PPR was also calculated for each dimension among sub-categories of respondents (physician, nurse, senior management, frontline staff).

For analysis, individual responses were aggregated to the hospital level and the hospital was the unit of analysis as in prior studies (Singer et al. 2009b–d). To ensure the appropriateness of aggregation of individual responses to the hospital level, we used one-way analysis of variance models and calculated intraclass correlation coefficients for the population as a whole as well as for each work role studied. These coefficients were significant for all domains of safety culture. We also calculated Cronbach α, the interclass correlation among hospitals and the $R_{wg(j)}$ statistic (Vogus and Sutcliffe 2007b) for all groups studied and results supported aggregation of responses (available as online supplement). One domain, unit recognition and support for safety efforts, demonstrated marginal justification for aggregation among physicians respondents.

In July 2009, CMS began reporting risk-standardized mortality and readmission outcomes collected between 2007 and 2008 for Medicare patients following hospitalization for pneumonia, HF, and AMI. The measures use Medicare claims data in the calculation of risk-standardized rates that are adjusted for individual patient's age, gender, and selected comorbidities. A hospital's risk-standardized readmission rate is calculated using hierarchical regression models which include coefficients for patient-level comorbidities and a hospital-level intercept which represents hospital-level variation in the 30-day readmission rate to any hospital. Variation in the hospital-level intercept is attributed to variation in hospital quality. The "predicted" readmission rate (estimated given an individual hospital's case mix and the hospital's own intercept derived from the regression model based on its case mix and observed readmission rate) is divided by the hospital's "expected" readmission rate (estimated given the case mix of the individual hospital along with the average hospital-specific intercept). This is then multiplied by the national unadjusted readmission rate to yield a hospital-specific risk standardized readmission rate. This methodology has been validated against medical record review (Keenan et al. 2008).

Sample

We used a large random sample of all acute-care hospitals in the United States according to size and geographic region. Eight hospitals responding to the PSCHO did not have readmission outcome data available for any of the diagnoses studied and were excluded from the analysis. The final sample of 67 hospitals differed from the United States average size and related characteristics as a result of the recruitment strategy (Table 1). In addition, hospitals located in the Midwest were underrepresented in the final sample. Eleven hospitals did not provide AMI outcome data as a result of insufficient volume but were included in the analyses of HF and pneumonia outcomes. Readmission rates at hospitals reporting readmission rates were similar to national averages for AMI and pneumonia and were slightly lower compared with national averages for HF.

Surveys were administered between July 2006 and May 2007. The sampling frame consisted of 36,375 hospital employees. Because of the historically low response rates among physicians and the relatively small numbers of hospital senior managers and physicians, these groups were oversampled. Other respondents selected were from a 10 percent random sample of hospital employees.

Independent Variables. The primary independent variables were the 12 component domains of patient safety climate as well as a summary measure of safety climate calculated as the average of all survey items. Primary independent variables for the analysis included multiple dichotomous variables describing management level and work role. For management level variables, senior managers included individuals who self-identified as department head or above, and frontline staff members were individuals who indicated that they were neither senior managers nor supervisors and included physicians, nurses, and patient care technicians. Two work roles, physician and nurse, were assigned dummy variables.

Dependent Variables. Our primary outcomes of interest were 30-day risk-standardized readmission for AMI, HF, and pneumonia.

Table 1: Survey Hospital Characteristics Compared to American Hospital Association Averages

Control Variables	*Sample Hospitals (N= 67)* Frequency	*Sample Hospitals (N= 67)* Percent	*All US Hospitals Excluding VA and Children's Hospitals (N= 4,689)* Frequency	*All US Hospitals Excluding VA and Children's Hospitals (N= 4,689)* Percent	*p Value for t-Test or χ^2*
Region					<.0001
Northeast	20	29.9	608	13.0	
Midwest	11	16.4	1378	29.4	
South	16	23.9	1798	38.4	
West	20	29.9	905	19.3	
Teaching status					<.0001
Major teaching	13	19.4	275	5.9	
Other teaching	14	20.1	545	11.6	
Nonteaching	40	59.7	3869	82.5	
Metropolitan					.0252
Yes	47	70.1	2640	56.3	
No	20	29.9	2049	43.7	
Bed size					<.0001
Small ($\leq$ 99)	15	22.4	2295	48.9	
Medium (100–249)	15	22.4	1375	29.3	
Large ($\geq$ 250)	37	55.2	1019	21.7	
Tax status					
For profit	3	4.4			
Government	11	16.4			
Not for profit	53	79.1			
Nurse staffing ratio					
Mean (SD)	11.9	(5.0)	15.1	(30.8)	<.0001

Mean Risk-Standardized 30-day Readmission Rates (%)	*Sample Hospitals* N	*Sample Hospitals* % (SD)	*All US Hospitals Excluding VA and Children's Hospitals* N	*All US Hospitals Excluding VA and Children's Hospitals* % (SD)	*p Value for t-Test*
AMI	56	19.9 (1.5)	2462	19.9 (1.3)	.1908
HF	67	24.0 (2.0)	3906	24.5 (2.1)	.0346
Pneumonia	67	18.1 (1.6)	4043	18.2 (1.7)	.4859

Control Variables. Covariates were considered for inclusion in multivariate models based on suspected relationship to safety climate or readmission. Given our small sample size, we conducted a two-step process to identify the minimum number of appropriate controls. First, we identified all control variables we suspected might be related. Then, we ran all the models related to a particular dependent variable individually and identified the control variables that were significant for each model. In initial models, data for hospital characteristics (number of staffed beds, tax status, urban/rural location, teaching status, and geographic region) were obtained from the American Hospital Association's (2004) Annual Survey of Hospitals. Nurse staffing ratios were calculated as the full-time equivalent registered nurse hours per inpatient days. Within each of the three groupings studied (frontline versus senior management, physician versus nurse, entire population), we retained the variables that were significant for greater than one-third of models analyzed. Models examining associations specifically by management level and work role included hospital tax status, region, and nurse staffing ratios as covariates. Nurse staffing ratios were not significant in models for the entire population and this variable was omitted from these models.

Statistical Analysis. We tested our study hypotheses using multiple regression in which readmission rates were the dependent variables in separate disease-specific models and measures of safety climate were the main independent variables. We estimated separate models for all hospital staff as well as physicians, nurses, hospital senior managers, and frontline staff. All standard errors were robust to account for heteroskedasticity.

RESULTS

The overall response rate to the PSCHO was 38.5 percent. From the sample of 36,375 individuals, a total of 14,010 surveys were returned. Among the population of hospitals for which readmission data were available, the response rate was 31.3 percent. The total number of respondents among responding hospitals ranged between 44 and 604. Physician respondents ranged from 2 to 340; nurse respondents from 8 to 189; frontline staff from 17 to 434; and senior managers from 6 to 98. Physician response rate (20.16 percent) was lower than that recorded for senior managers (62.16 percent), or other staff (50.10 percent). Lower physician response has been observed in similar studies of clinicians (Asch, Jedrziewski, and Christakis 1997; Singer et al. 2009d).

Regression models supported Hypothesis 1, which predicted that higher levels of hospital safety climate would be associated with lower 30-day readmission. Overall, there was a significant positive association between hospitals with higher PPR (i.e., lower safety climate) and those with higher readmission

Table 2: Relationship of Patient Safety Climate to Readmission Rates for Acute Myocardial Infarction (AMI), Heart Failure (HF), and Pneumonia (PNA)

	AMI	*HF*	*PNA*
Senior management engagement	0.0804** (0.0157–0.145)	0.0744* (– 0.0125 to 0.161)	0.0264 (– 0.0587 to 0.112)
Organizational resources	0.0642* (– 0.00274 to 0.131)	0.0705 (– 0.0220 to 0.163)	0.0395 (– 0.0367 to 0.116)
Overall emphasis on safety	0.0968*** (0.0336–0.160)	0.113*** (0.0342–0.191)	0.0476 (– 0.0389 to 0.134)
Problem responsiveness	0.0853** (0.00805–0.163)	0.0903* (– 0.0141 to 0.195)	0.017 (– 0.0702 to 0.104)
Unit safety norms	0.186*** (0.0914–0.281)	0.259*** (0.104–0.414)	0.0193 (– 0.134 to 0.172)
Unit recognition and support	0.0345 (– 0.0288 to 0.0978)	0.0599 (– 0.0123 to 0.132)	0.0263 (– 0.0466 to 0.0991)
Unit manager support	0.0506 (– 0.0253 to 0.126)	0.0344 (– 0.0541 to 0.123)	0.0201 (– 0.0532 to 0.0934)
Collective learning	0.116** (0.00770 to 0.225)	0.160*** (0.0429 to 0.278)	0.0454 (– 0.0724 to 0.163)
Psychological safety	0.0644 (– 0.0578 to 0.187)	0.0602 (– 0.0597 to 0.180)	0.011 (– 0.0900 to 0.112)
Fear of shame	0.0126 (– 0.213 to 0.238)	– 0.0827 (– 0.277 to 0.111)	0.0831 (– 0.0837 to 0.250)
Fear of blame	0.051 (– 0.0158 to 0.118)	0.106*** (0.0365 to 0.176)	0.0611* (– 0.00182 to 0.124)
Provision of safe care	– 0.0138 (– 0.0831 to 0.0555)	0.0067 (– 0.0708 to 0.0842)	0.02 (– 0.0456 to 0.0857)
Overall	0.123** (0.0164 to 0.229)	0.160** (0.0210–0.299)	0.0715 (– 0.0689 to 0.212)

Note. Values represent standardized β coefficients; 95% confidence interval in parentheses. Models adjusted for census region where the hospital is located and whether the hospital was for-profit, nonprofit, or government owned.

***$p<.01$; **$p<.05$; *$p<.1$.

rates for AMI and HF ($p \leq .05$) but not for pneumonia (Table 2). The safety climate dimensions that most consistently demonstrated statistically significant association with readmission were "unit safety norms," "overall emphasis on safety," and "collective learning." Each of these domains demonstrated statistical significance at the 0.05 level for both AMI and HF. The standardized regression coefficients for the regression of the "safety norms" dimension on AMI and HF readmission outcomes were 0.19 [0.09–0.28 95 percent CI, $p \leq .01$] and 0.26 [0.10–0.41 95 percent CI, $p \leq .01$], respectively. This indicates that a 1 percent lower PPR for this domain was associated with a 0.19

percent lower absolute incidence of readmission following AMI and 0.26 percent lower readmissions following HF exacerbation.

Results also support Hypothesis 2, which predicted that frontline staff perceptions regarding safety climate will be more closely associated with patient readmission than senior management perceptions. Frontline staff perceptions were associated with readmission rates for AMI and HF ($p \leq .01$), but senior management perceptions were not. Not only were frontline staff perceptions of safety climate overall found to be significantly associated with AMI and HF readmission rates (0.11 [95 percent CI 0.01–0.21] and 0.17 [95 percent CI 0.04–0.29], respectively), but their perceptions of more dimensions of safety climate were associated with readmissions than those of senior management (Table 3). For frontline staff, PPR was significantly associated with HF and AMI readmission for 11 of 24 measurements, while for senior managers only 3 of 24 possible relationships were significant.

Results additionally support Hypothesis 3. Nurse perceptions of safety climate were more closely associated with readmission rates for HF, a condition requiring support of chronic disease following discharge, while physician perceptions of safety climate were more closely associated with readmission following hospitalization for the more acute and procedure-dependent AMI diagnosis (i.e., physician-driven readmission rates) (Table 4). Physician PPR was significantly associated with AMI readmission for 6 of 12 domains, while nurse PPR had no significant association with AMI readmission. In contrast, nurse PPR demonstrated significant association with HF readmission in four domains, physician PPR was only associated with HF readmission for a single domain. Hospitals with a higher PPR among nurses were more likely to experience higher readmission rates following HF exacerbation (0.08 [95 percent CI 0.00–0.17]), while hospitals with a higher PPR among physicians were more likely to experience higher readmission rates after AMI (0.08 [95 percent CI 0.03–0.14]). Associations with pneumonia readmission were not significant.

Discussion

Our examination of the relationship between patient safety climate and hospital readmission indicates that hospital staff perceptions of patient safety climate are associated with an important clinical outcome among patients admitted with AMI and HF. While previous studies established a relationship between safety climate and inpatient outcomes (Pronovost et al. 2005;

Table 3: Relationship of Patient Safety Climate to Readmission Rates for Acute Myocardial Infarction (AMI) and Heart Failure (HF) by Management Level

	Frontline Staff		*Senior Management*	
	AMI	*HF*	*AMI*	*HF*
Senior management engagement	0.0873*** (0.0278–0.147)	0.0831* (– 0.00101 to 0.167)	0.0074 (– 0.0456 to 0.0604)	0.0422 (– 0.0208 to 0.105)
Organizational resources	0.0754*** (0.0205–0.130)	0.0732* (– 0.00291 to 0.149)	– 0.0182 (– 0.0659 to 0.0296)	0.0123 (– 0.0443 to 0.0689)
Overall emphasis on safety	0.0881*** (0.0356–0.141)	0.105*** (0.0396–0.170)	0.0311 (– 0.0173 to 0.0795)	0.0718*** (0.0325–0.111)
Problem responsiveness	0.0798** (0.00821–0.151)	0.0938** (0.00134–0.186)	0.0441 (– 0.0132 to 0.101)	0.0719** (0.00493–0.139)
Unit safety norms	0.124*** (0.0549–0.194)	0.200*** (0.0801–0.320)	0.0262 (– 0.0178 to 0.0701)	0.0655*** (0.0223–0.109)
Unit recognition and support	0.0428 (– 0.0153 to 0.101)	0.0497 (– 0.0237 to 0.123)	0.0001 (– 0.0468 to 0.0470)	0.0304 (– 0.0178 to 0.0786)
Unit manager support	0.0478 (– 0.0209 to 0.117)	0.0331 (– 0.0421 to 0.108)	0.0372 (– 0.0248 to 0.0993)	0.0513* (– 0.00364 to 0.106)
Collective learning	0.113*** (0.0300–0.196)	0.127*** (0.0348–0.219)	– 0.00707 (– 0.0825 to 0.0683)	0.0378 (– 0.0503 to 0.126)
Psychological safety	0.0715 (– 0.0273 to 0.170)	0.0719 (– 0.0323 to 0.176)	0.000883 (– 0.0739 to 0.0757)	0.0343 (– 0.0518 to 0.120)
Fear of shame	0.0147 (– 0.157 to 0.187)	0.0317 (– 0.134 to 0.197)	0.0283 (– 0.0880 to 0.145)	0.0334 (– 0.161 to 0.228)
Fear of blame	0.0415 (– 0.0176 to 0.101)	0.0961*** (0.0405–0.152)	0.0524 (– 0.0158 to 0.121)	0.0498 (– 0.0151 to 0.115)
Provision of safe care	0.00919 (– 0.0656 to 0.0840)	0.00575 (– 0.0763 to 0.0878)	– 0.0233 (– 0.0626 to 0.0160)	– 0.0237 (– 0.0668 to 0.0194)
Overall	0.128*** (0.0345–0.221)	0.163*** (0.0407–0.286)	0.0144 (– 0.0546 to 0.0835)	0.0646 (– 0.0133 to 0.143)

Note. Values represent standardized β coefficients, 95% confidence interval in parentheses. Models adjusted for census region where the hospital is located; whether the hospital was for-profit, nonprofit, or government owned; the ratio of full time nurse equivalent hours to inpatient days.

***$p<.01$; **$p<.05$; *$p<.1$.

Table 4: Relationship of Patient Safety Climate to Readmission Rates for Acute Myocardial Infarction (AMI) and Heart Failure (HF) by Work Role

	Physician		Nurse	
	AMI	*HF*	*AMI*	*HF*
Senior management engagement	0.0626***	0.0443*	0.0247	0.0368
	(0.0318–0.0934)	(– 0.0012 to 0.0898)	(– 0.0125 to 0.0618)	(– 0.0104 to 0.0840)
Organizational resources	0.0374	0.0379	0.0267	0.0414*
	(– 0.0136 to 0.0883)	(– 0.0193 to 0.0952)	(– 0.0146 to 0.0680)	(– 0.0062 to 0.0889)
Overall emphasis on safety	0.0540***	0.0401*	0.0272	0.0583***
	(0.0280–0.0801)	(– 0.0056 to 0.0858)	(– 0.0191 to 0.0735)	(0.0151–0.1015)
Problem responsiveness	0.0429**	0.0403*	0.021	0.0348
	(0.0036–0.0822)	(– 0.0078 to 0.0883)	(– 0.0269 to 0.0689)	(– 0.0237 to 0.0932)
Unit safety norms	0.0800***	0.027	0.0828*	0.155***
	(0.0222–0.1379)	(– 0.0383 to 0.0923)	(– 0.00904 to 0.17456)	(0.0599–0.2498)
Unit recognition and support	0.0317	0.0429*	0.00503	0.0484
	(– 0.0190 to 0.0824)	(– 0.0053 to 0.0912)	(– 0.0463 to 0.0564)	(– 0.0126 to 0.1095)
Unit manager support	0.0524***	0.0377*	0.0195	0.00971
	(0.0159–0.0888)	(– 0.0068 to 0.0823)	(– 0.0237 to 0.0627)	(– 0.0413 to 0.0607)
Collective learning	0.0682***	0.0341	0.0299	0.0761**
	(0.0306–0.1059)	(– 0.0188 to 0.0870)	(– 0.0324 to 0.0923)	(0.0107–0.1414)
Psychological safety	0.0191	– 0.0103	– 0.0199	0.0179
	(– 0.0547 to 0.0929)	(– 0.0749 to 0.0544)	(– 0.0957 to 0.0560)	(– 0.0687 to 0.1046)
Fear of shame	0.0388	0.0699**	– 0.0845	– 0.160*
	(– 0.0673 to 0.1450)	(0.0024–0.1373)	(– 0.247 to 0.078)	(– 0.344 to 0.024)
Fear of blame	– 0.00236	0.0196	0.036	0.0569**
	(– 0.0418 to 0.0371)	(– 0.0156 to 0.0548)	(– 0.0131 to 0.0851)	(0.0009–0.1128)
Provision of safe care	– 0.0107	– 0.00709	– 0.0179	0.0279
	(– 0.0630 to 0.0415)	(– 0.0475 to 0.0333)	(– 0.0720 to 0.0361)	(– 0.0299 to 0.0858)
Overall	0.0829***	0.0652*	0.0407	0.0832**
	(0.0284–0.1373)	(– 0.0089 to 0.1393)	(– 0.0351 to 0.1165)	(0.0003–0.1661)

Note. Values represent standardized β coefficients; 95% confidence interval in parentheses. Models adjusted for census region where the hospital is located; whether the hospital was for-profit, nonprofit, or government owned; the ratio of full-time nurse equivalent hours to inpatient days.
***$p<.01$; **$p<.05$; *$p<.1$.

Hofmann and Mark 2006; Vogus and Sutcliffe 2007a), our data indicate that better safety climate may also have measurable effects on the postdischarge outcome of readmissions. Moreover, associations between hospital staff's perceptions of safety climate and readmission rates varied by both management level and clinical work role. The three domains of safety climate that demonstrated the most statistically significant associations with HF and AMI were unit safety norms, overall emphasis on safety, and collective learning. It is notable that each of these domains is manifest at a collective level rather than an individual level, in contrast to more individual-focused domains such as fear of shame or blame and individual provision of safe care. This may indicate that organizational rather than interpersonal factors are particularly operative in the relationship between safety climate and readmission.

The relationship identified in our analysis may be attributable in part to two determinants of readmission. First, previous research shows that discharging patients despite inadequate readiness is associated with higher risk of readmission (Ashton et al. 1995; Ashton and Wray 1996; Michel et al. 2000). Our data suggest that institutions whose workers perceive lower safety climate may be less likely to identify or intervene to prevent premature discharges. Second, patients with chronic disease often experience both initial hospital admission and readmission as a result of inadequate self-management. Patient education at the time of initial admission is an important means to alter behavior and reduce the risk of readmission (Krumholz et al. 2002; McAlister et al. 2004); however, hospitals with lower safety climate may be less likely to devote adequate effort to this educational process.

The relative accuracy of frontline staff compared with senior management in identifying weaknesses in safety climate associated with worse patient outcomes represents an important finding for health care managers wishing to improve patient outcomes. Our results, similar to previous studies measuring the accuracy of managers' perceptions of frontline processes (Singer et al. 2009d), indicate that organizations may require dedicated initiatives in order to inform senior management involvement in improving patient care. The appropriateness of management perceptions of safety climate may be specifically important to the goal of delivering safe transitions because many evidence-based interventions to reduce readmission require new institutional processes (e.g., standardized discharge checklists) or institutional resources (e.g., follow-up phone calls to patients or pharmacist review of patients' medication regimens) and so rely on senior manager involvement.

Our finding that different work roles appear to offer unique insights into disease-specific readmission risk supports efforts to reduce hospital readmission through attention to differences between chronic disease exacerbations and other acute conditions. Our data do not allow for a determination of which elements of the nurse–patient relationship or nurses' work role account for perceptions more reflective of hospitals' HF readmission outcomes, but a potential explanation may lie in the relatively extensive patient interaction offered in the nursing role and associated insight into patients' safety for discharge. In addition, of the diagnoses studied, HF management is perhaps the most dependent on patient education at discharge—a responsibility that often rests largely with nursing and may explain the relative accuracy of nurses' perceptions.

The notable absence of an observed association between safety climate and pneumonia readmission may be explained by some of the unique characteristics of this diagnostic category. First, pneumonia education at discharge is relatively limited compared with the extensive self-management and lifestyle change instruction recommended for HF and cardiac risk reduction following AMI. This may limit the role that safety climate might play in reducing pneumonia readmission risk through more conscientious patient education at the time of discharge. In addition, factors other than hospital-level factors may determine the likelihood of pneumonia readmission (e.g., patient demographics or comorbidities), making pneumonia relatively less sensitive to changes in safety climate. The lack of an association in contrast to HF and AMI is distinctive and merits further study.

It should be noted that we did not uniformly identify a significant relationship between safety climate and readmission and that a full conceptual model to explain the relationship we have identified remains to be fully developed. It is likely that the effect of safety climate on readmission is indirect. Several process strategies such as enhanced patient education, medication reconciliation, and confirmed follow-up have been shown to reduce readmission (Coleman et al. 2006; Schnipper et al. 2006; Jack et al. 2009; Koehler et al. 2009). The effectiveness of these process strategies may be modified by variation in safety climate, particularly in clinical settings outside a research trial. An exploration of interactions between safety climate and discharge process strategies on the incidence of readmission merits further study.

Our study has some limitations. Though our data were derived from a random hospital sample, this sample differed from U.S. hospitals overall and so may not be directly generalizable. Study hospitals were more likely to be large academic centers, and hospitals in the Midwest were underrepresented compared with the national average. However, it is unclear how these characteristics of the sample might affect the relationship between safety climate and readmissions. While attempts were made to mitigate nonresponse bias by oversampling physicians, survey response rates did vary by work role, with physicians less likely to respond. Our study is subject to the limitations inherent in any cross-sectional analysis, including the possibility of unmeasured. While we cannot exclude this possibility, our analysis does account for issues of reverse causality encountered in cross-sectional research through the use of safety climate measures obtained 1 year before analyzed readmission rates.

In summary, we have identified positive associations between better hospital patient safety climate and reduced 30-day risk-standardized hospital readmission for patients hospitalized with HF or AMI. This finding supports ongoing initiatives to measure and improve hospital patient safety climate and supports the validity of both the safety climate survey and the risk-standardized readmission measures. More research is needed to further clarify the relationship between safety climate and readmission as well as to build and test possible causal models explaining this relationship. The potential for improvement in safety climate to reduce readmission may be important to policy makers in the context of federal health care reform legislation identifying reduction of avoidable hospital readmission as a means to reduce costs and improve quality of health care.

Acknowledgments

Joint Acknowledgment/Disclosure Statement: Since the time of initial submission, this work was presented at the 2010 Annual Meeting of the Society of Hospital Medicine (April 8–11, Washington, DC) and the AcademyHealth 2010 Annual Meeting (June 27–29, Boston, MA).

Disclosures: None.

Disclaimers: None.

References

AHRQ. 2009a. "Educating Patients Before They Leave the Hospital Reduces Readmissions, Emergency Department Visits and Saves Money" [accessed on January 24, 2009a]. Available at http://www.ahrq.gov/news/press/pr2009/redpr.htm

AHRQ. 2009b. "Patient Safety Primer: Adverse Events after Hospital Discharge" [accessed on January 25, 2009b]. Available at http://www.psnet.ahrq.gov/primer.aspx?primerID=11

American Hospital Association. 2004. *The Annual Survey of Hospitals Database: Documentation for 2004 Data.* Chicago, IL: American Hospital Association.

Asch, D., M. Jedrziewski, and N. Christakis. 1997. "Response Rates to Mail Surveys Published in Medical Journals." *Journal of Clinical Epidemiology* 50 (10): 1129–36.

Ashton, C., D. Del Junco, J. Souchek, N. Wray, and C. Mansyur. 1997. "The Association between the Quality of Inpatient Care and Early Readmission: A Meta-Analysis of the Evidence." *Medical Care* 35 (10): 1044–59.

Ashton, C., and N. Wray. 1996. "A Conceptual Framework for the Study of Early Readmission as an Indicator of Quality of Care." *Social Science & Medicine* 43 (11): 1533–41.

Ashton, C. M., D. H. Kuykendall, M. L. Johnson, N. P. Wray, and L. Wu. 1995. "The Association between the Quality of Inpatient Care and Early Readmission." *Annals of Internal Medicine* 122 (6): 415–21.

Balaban, R., J. Weissman, P. Samuel, and S. Woolhandler. 2008. "Redefining and Redesigning Hospital Discharge to Enhance Patient Care: A Randomized Controlled Study." *Journal of General Internal Medicine* 23 (8): 1228–33.

Chung, E. S., L. Guo, D. E. Jr. Casey, C. Bartone, S. Menon, S. Saghir, A. Mital, and D. J. Kereiakes. 2008. "Relationship of a Quality Measure Composite to Clinical Outcomes for Patients with Heart Failure." *American Journal of Medical Quality* 23 (3): 168–75.

Clarke, S. 2006. "The Relationship between Safety Climate and Safety Performance: A Meta-Analytic Review." *Journal of Occupational Health Psychology* 11 (4): 315–27.

Coleman, E., and M. Williams. 2007. "Executing High-Quality Care Transitions: A Call to Do It Right." *Journal of Hospital Medicine* 2 (5): 287–90.

Coleman, E. A., C. Parry, S. Chalmers, and S. J. Min. 2006. "The Care Transitions Intervention: Results of a Randomized Controlled Trial." *Archives of Internal Medicine* 166 (17): 1822–8.

David, M. S., G.-H. Anita, W. Morris, Z. O. Eugene, G. H. William, A. A. David, M. A. Carol, R. F. John, G. Paulette, M. H. James, M. H. Denise, L. Lawrence, and E. M. Charles. 2000. "Predicting Non-Elective Hospital Readmissions: A Multi-Site Study." *Journal of Clinical Epidemiology* 53 (11): 1113–8.

Dobrzanska, L., and R. Newell. 2006. "Readmissions: A Primary Care Examination of Reasons for Readmission of Older People and Possible Readmission Risk Factors." *Journal of Clinical Nursing* 15 (5): 599–606.

Epstein, A. 2009. "Revisiting Readmissions—Changing the Incentives for Shared Accountability." *New England Journal of Medicine* 360 (14): 1457–59.

Friedman, B., W. Encinosa, H. Jiang, and R. Mutter. 2009. "Do Patient Safety Events Increase Readmissions?" *Medical Care* 47 (5): 583–90.

Hartmann, C., M. Meterko, and A. Rosen. 2009. "Relationship of Hospital Organizational Culture to Patient Safety Climate in the Veterans Health Administration." *Medical Care Research and Review* 66 (3): 320–28.

Hofmann, D., and B. Mark. 2006. "An Investigation of the Relationship between Safety Climate and Medication Errors as Well as Other Nurse and Patient Outcomes." *Personnel Psychology* 59 (4): 847–69.

IOM. 2006. *Committee on Identifying and Preventing Medication Errors Board on Health Care Services. Preventing Medication Errors.* Washington, DC: Institute of Medicine.

Jack, B., V. Chetty, D. Anthony, J. Greenwald, G. Sanchez, A. Johnson, S. Forsythe, J. O'Donnell, M. Paasche-Orlow, and C. Manasseh. 2009. "A Reengineered Hospital Discharge Program to Decrease Rehospitalization: A Randomized Trial." *Annals of Internal Medicine* 150 (3): 178–87.

Jencks, S. F., M. V. Williams, and E. A. Coleman. 2009. "Rehospitalizations among Patients in the Medicare Fee-for-Service Program." *New England Journal of Medicine* 360 (14): 1418–28.

Keenan, P., S. Normand, Z. Lin, E. Drye, K. Bhat, J. Ross, J. Schuur, B. Stauffer, S. Bernheim, and A. Epstein. 2008. "An Administrative Claims Measure Suitable for Profiling Hospital Performance on the Basis of 30-day All-Cause Readmission Rates among Patients with Heart Failure." *Circulation: Cardiovascular Quality and Outcomes* 1 (1): 29–37.

Koehler, B., K. Richter, L. Youngblood, B. Cohen, I. Prengler, D. Cheng, and A. Masica. 2009. "Reduction of 30-Day Postdischarge Hospital Readmission or Emergency Department (ED) Visit Rates in High-Risk Elderly Medical Patients through Delivery of a Targeted Care Bundle." *Journal of Hospital Medicine* 4 (4): 211–18.

Krumholz, H., J. Amatruda, G. Smith, J. Mattera, S. Roumanis, M. Radford, P. Crombie, and V. Vaccarino. 2002. "Randomized Trial of an Education and Support Intervention to Preventreadmission of Patients with Heart Failure." *Journal of the American College of Cardiology* 39 (1): 83–9.

McAlister, F., S. Stewart, S. Ferrua, and J. McMurray. 2004. "Multidisciplinary Strategies for the Management of Heart Failure Patients at High Risk for Admission: A Systematic Review of Randomized Trials." *Journal of the American College of Cardiology* 44 (4): 810–9.

MedPAC. 2007. *Paymemt Policy for Inpatient Readmissions. In Report to the Congress: Reforming the Delivery System.* Washington, DC: Medicare Payment Advisory Commission.

Michel, P. K., P. S. FranÃ§ois, V. P. Thomas, C. Pierre, S. Philippe, and G. Jean-Michel. 2000. "Unplanned Readmissions of Patients with Congestive Heart Failure: Do they Reflect In-Hospital Quality of Care or Patient Characteristics?" *The American Journal of Medicine* 109 (5): 386–90.

Naylor, M., D. Brooten, R. Campbell, B. Jacobsen, M. Mezey, M. Pauly, and J. Schwartz. 1999. "Comprehensive Discharge Planning and Home Follow-Up of Hospitalized Elders: A Randomized Clinical Trial." *Journal of American Medical Association* 281 (7): 613–620.

NQF. 2009. "Safe Practices for Better Healthcare 2009 Update" [accessed on January 25, 2009]. Available at http://www.qualityforum.org/Publications/2009/03/Safe_Practices_for_Better_Healthcare%E2%80%932009_Update.aspx.

Pronovost, P., B. Weast, B. Rosenstein, J. Sexton, C. Holzmueller, L. Paine, R. Davis, and H. Rubin. 2005. "Implementing and Validating a Comprehensive Unit-Based Safety Program." *Journal of Patient Safety* 1 (1): 33–40.

Roberts, K. H. 1990. "Some Characteristics of One Type of High Reliability Organization." *Organization Science* 1 (2): 160–76.

Rosen, A. K., S. Singer, S. Zhao, P. Shokeen, M. Meterko, and D. Gaba. 2010. "Hospital Safety Climate and Safety Outcomes: Is There a Relationship in the VA?" *Medical Care Research Review* 167 (5): 590–608.

Schnipper, J., J. Kirwin, M. Cotugno, S. Wahlstrom, B. Brown, E. Tarvin, A. Kachalia, M. Horng, C. Roy, and S. McKean. 2006. "Role of Pharmacist Counseling in Preventing Adverse Drug Events after Hospitalization." *Archives of Internal Medicine* 166 (5): 565–71.

Sexton, J. B., R. L. Helmreich, T. B. Neilands, K. Rowan, K. Vella, J. Boyden, P. R. Roberts, and E. J. Thomas. 2006. "The Safety Attitudes Questionnaire: Psychometric Properties, Benchmarking Data, and Emerging Research." *BMC Health Service Research* 6 (44): 1472–6963.

Singer, S., A. Falwell, D. Gaba, and L. Baker. 2008. "Patient Safety Climate in US Hospitals: Variation by Management Level." *Medical Care* 46 (11): 1149–56.

Singer, S., A. Falwell, D. Gaba, M. Meterko, A. Rosen, C. Hartmann, and L. Baker. 2009a. "Identifying Organizational Cultures That Promote Patient Safety." *Health Care Management Review* 34 (4): 300–11.

Singer, S., D. Gaba, A. Falwell, S. Lin, J. Hayes, and L. Baker. 2009b. "Patient Safety Climate in 92 US Hospitals: Differences by Work Area and Discipline." *Medical Care* 47 (1): 23–31.

Singer, S., C. Hartmann, A. Hanchate, S. Zhao, M. Meterko, P. Shokeen, S. Lin, D. Gaba, and A. Rosen. 2009c. "Comparing Safety Climate between Two Populations of Hospitals in the United States." *Health Services Research* 44 (5, part 1): 1563–83.

Singer, S., S. Lin, A. Falwell, D. Gaba, and L. Baker. 2009d. "Relationship of Safety Climate and Safety Performance in Hospitals." *Health Services Research* 44: 399–421.

Singer, S., M. Meterko, L. Baker, D. Gaba, and A. Falwell. 2007. "Workforce Perceptions of Hospital Safety Culture: Development and Validation of the Patient Safety Climate in Healthcare Organizations Survey." *Health Services Research* 42 (5): 1999–2021.

Sorra, J., and V. Nieva. 2003. *Psychometric Analysis of the Hospital Survey on Patient Safety. Final Report to Agency for Healthcare Research and Quality (AHRQ).* Washington, D.C.: AHRQ.

The Joint Commission. 2006. *Sentinel Event Alert: Behaviors That Undermine a Culture of Safety. Sentinel Event Alert.* Oakbrook Terrace, IL: The Joint Commission.

Tsuchihashi, M., H. Tsutsui, K. Kodama, F. Kasagi, S. Setoguchi, M. Mohr, T. Kubota, and A. Takeshita. 2001. "Medical and Socioenvironmental Predictors of Hospital Readmission in Patients with Congestive Heart Failure." *American Heart Journal* 142 (4): E7.

Vinson, J., M. Rich, J. Sperry, A. Shah, and T. McNamara. 1990. "Early Readmission of Elderly Patients with Congestive Heart Failure." *Journal of the American Geriatrics Society* 38 (12): 1045–46.

Vogus, T., and K. Sutcliffe. 2007a. "The Impact of Safety Organizing, Trusted Leadership, and Care Pathways on Reported Medication Errors in Hospital Nursing Units." *Medical Care* 45 (10): 997–1002.

———. 2007b. "The Safety Organizing Scale: Development and Validation of a Behavioral Measure of Safety Culture in Hospital Nursing Units." *Medical Care* 45 (1): 46–54.

Zohar, D. 1980. "Safety Climate in Industrial Organizations: Theoretical and Applied Implications." *Journal of Applied Psychology* 65 (1): 96–102.

Supporting Information

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.
Appendix SA2: Indices of Agreement.
Table S1: Cronbach's Alpha for Study Sample and Sub-groups.
Table S2: Interclass Correlation, F statistic and $R_{wg(j)}$.